EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON THE GROWTH AND YIELD OF TOMATO (*Lycopersicon esculentum*)

By

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CERTIFICATE

This is to certify that thesis entitled, *"EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON THE GROWTH AND YIELD OF TOMATO (Lycopersicon esculentum)"* submitted to the DEPARTMENT OF SOIL SCIENCE, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirement for the degree of MASTER OF SCIENCE (M.S) IN SOIL SCIENCE embodies the result of a piece of bona fide research work carried out by MST. AFRINA AKHTER, Registration No. 11-04683, under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged by him.

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DEDICATED TO
MY
BELOVED PARENTS

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ABSTRACT

A field experiment was conducted at the research farm of Sher-e- Bangla Agricultural University, Dhaka, during November 2011 to March 2012 to study the effect of integrated nutrient management on the growth and yield of tomato. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replication of each treatment. The unit plot size was $6m^2$ (3m×2m). There were 9 treatment combinations in the experiment comprising 9 levels of N (180 kg/ha from Urea , 155 kg/ha from Urea + 25kg/ha from CD, 130 kg/ha from Urea + 50kg/ha from CD , 105 kg/ha from Urea + 75kg/ha from CD, 80 kg/ha from Urea + 100kg/ha from CD, 55 kg/ha from Urea + 125kg/ha from CD, 30 kg/ha from Urea + 150kg/ha from CD) and single level of P & K.(25kg P/ha from TSP + 60kg K/ha from MP). The maximum plant height (67.03cm) was recorded from T_5 treatment consisting of 80 kg N/ha from Urea +100 kg N/ha from CD and the minimum plant height (47.50 cm) was recorded from T_9 treatment i.e. control condition. The highest and lowest number of leaf per plant was 98.89 and 61.59 recorded from T_4 and T_9 treatment respectively. The highest and lowest no. of fruit/plant was 67.07 and 38.51 recorded from T_5 and control treatment respectively. The highest and lowest yield per plot 46.43 kg/ha and 26.66 kg/ha was recorded from T_5 and control treatment respectively. The maximum yield (77.39 t/ha) was recorded from T_5 treatment and the minimum yield (44.43 t/ha) was recorded from the T_9 treatment. The highest nitrogen content (1.63%) in plant was recorded from T_4 treatment and the lowest nitrogen content (0.82%) in plant was recorded from T_9 treatment. The highest phosphorus content (0.386%) in plant was recorded from T_1 treatment and the lowest phosphorus content (0.124%) in plant was recorded from T_9 treatment. The highest nitrogen content (0.081 %) in soil was recorded from T_1 treatment and the lowest Nitrogen content (0.050%) in soil was recorded from T_9 treatment. The highest phosphorus content (25.67 ppm) in soil was recorded from T_4 treatment and the lowest phosphorus content (20.60 ppm) in soil was recorded from T_9 treatment. The highest sulphur content (14.45 ppm) in post harvest soil was recorded from T_5 treatment and the lowest Sulphur content (11.28 ppm) in soil was recorded from T_2 treatment.

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Chapter 1

INTRODUCTION

Tomato (*Lycopersicon esculentum*), belonging to the family Solanaccae, is one of the most popular and quality vegetables grown in Bangladesh. It is originated in tropical America (Salunkhe *et al.*, 1987) and ranks third in terms of world vegetables production (FAO, 1997) and tops the list of canned vegetables (Choudhury, 1979). It is adapted to a wide range of climates ranging from tropic to within a few degree of the Arctic Circle. However, in spite of its broad adaptation, production is concentrated in a few area and rather dry area (Cuortero and Fernandez, 1999).

The popularity of tomato and different products produce from tomato processing is increasing day by day. It is a nutritious and delicious vegetable used in salads, soups, and processed into stable products like ketchup, sauce, marmalade, chutney and juice. These are extensively used in canning industry for canning. In Bangladesh, half of the population is under the poverty level and suffering from various health problems. A large number of children have clinical signs of vitamin A deficiency and more than 9, 00,000 children under six years of age suffering from some degree of xerophthalmia and over 30,000 children go under blind each year due to vitamin A deficiency. Nutritive value of the fruit is an important aspect of quality of tomato and public demand. Food value of tomato is very rich because of higher contents of vitamins A, B and C including Calcium and Carotene (Bose and Som, 1990). Tomato flavor to the foods and it is also rich in medicinal value.

The soil and climate condition of winter season of Bangladesh are congenial for tomato cultivation. Very recently some variety was developed for year round cultivation of tomato. Among the winter vegetable crops in Bangladesh, tomato ranks second in respect of production and third in respect of area (BBS, 2006). A wide range of latitude, soil types and methods of cultivation is suitable for tomato production. A night temperature of $15^{0}c$ to $20^{0}c$ ensures optimum fruit setting (Charles and Harris, 1972, Verkerk, 1995, Schiable, 1962). To get one ton fresh fruit, plants need to absorb on an average 2.5-3 kg N, 0.2-0.3 kg P and 3-3.5 kg K (Hedge, 1997). Recommended fertilizer does for cultivation is 550 kg/ha Urea, 450 kg/ha TSP, 250 kg/ha MP, 10 t/ha Cow dung.

Organic manure is a source of food for the innumerable number of microorganisms and creature like earthworm who breaks down these to micronutrients, which are easily absorbed by the plants. Organic manure plays a direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization, improving the physical and physiological properties of soils. Organic manure such as Cowdung, poultry manure and Vermicompost improves the soil structure, aeration, slow release nutrient which support root development leading to higher growth and yield of tomato plants. The macronutrient Calcium and micronutrients boron, manganese, molybdenum and iron are important for tomato cultivation. Biologically active soils with adequate organic matter usually supply enough of these nutrients.

Recent statistics showed that tomato was grown in 50470 acre of land of Bangladesh and the total production was approximately 150720 metric tons in 2008-2009 (BBS, 2009). Thus the average yield of tomato was 7.38 t/ha (BBS, 2009), while it was 69.41 t/ha in USA, 14.27 t/ha in India, 26.13 t/ha in China, 13.25 t/ha in Indonesia and 9.26 t/ha in Japan. The low yield of tomato in Bangladesh, however, is not an indication of low yield potentiality of this crop, but the fact that the lower yield may be attributed to a number of reasons, viz., unavailability of quality seeds of improved varieties, improper management of fertilizers, irrigation, disease control etc. Proper fertilizer management practices can improve this situation. Ali and Gupta (1978) reported that N, P and K fertilizer significantly increased the yield. Only three primary plant nutrients viz., nitrogen, phosphorus and potassium along with one secondary nutrient as sulphur are used by the farmers of Bangladesh for the cultivation of tomato. The importance of the use of micro nutrient is mostly ignored although it can be a chief limiting factor for crop production. Presently there has been great increase of fertilizer use, yet the proportion of different nutrients used in the country is not at all balanced. N along constitutes about 78% of the total nutrients used in the country which may not help improve crop productivity unless other limiting nutrients are supplemented along with nitrogen. In order to improve crop productivity, the limiting micro nutrient(s) must be identified and the soils should be enriched with addition of these nutrients in properly balanced fertilizer programmed. Integrated nutrient management (INM) integrates the use of all natural and man- made sources of plant nutrients, so that productivity and nutrient status of food increases in an efficient and environmentally benefiting manner without sacrificing soil productivity of future generations.

Considering the above facts, the present research was under taken with the following objectives:

- To study the effect of cowdung as organic source of nutrient on the growth and yield of Tomato.
- To evaluate the effect of integrated nutrient management on soil health and sustainable productivity.
- To find out the best combination of organic manure and inorganic fertilizer for successful tomato production.

Chapter 2

Review of Literature

Chapter 2

REVIEW OF LITERATURE

Tomato is one of the most important vegetable crop in Bangladesh as well as many countries of the world. It is a high yielding year round crop and fertilizer responsive crop. Among different fertilizer nitrogen, phosphorus and sulphur are three of the essential plant nutrient elements and each plays a significant role in tomato production. But a very few studies on the related to integrated nutrient management on growth, yield and development of tomato have been carried out in our country as well as many other countries of the world. The research work so far done in Bangladesh and is not adequate specific and conclusive. Nevertheless, some of important and informative works and research findings related to the integrated nutrient management so far been done at home and abroad on this crop have been reviewed here with the hope that this might contribute to the present study.

Sainju *et al.* (2001) conducted an experiment at Agricultural Research station, Fort valley State University, Fort valley to evaluated hairy vetch residue as nitrogen fertilizer for tomato in soilless medium. The ability of hairy vetch (vicia villosa Roth) residue (100 g / plant) to supply N and to increase yields of tomato (*Lycopersicon esculentum*) was compared with that of N fertilization (0, 4.1, and 8.2 g/plant) in a medium containing a mixture of 3 per liter: 1 vermiculite in a greenhouse. Leaf dry weight, leaf and stem N uptake, total dry weight and n uptake of tomato, and NH_4^+ and inorganic N concentrations in the medium of transplanting were significantly greater with than without residue. Nitrogen fertilization increased fruit number, fresh and dry yields and N uptake, stem, leaf, and root dry weights and N uptake, root length, and total dry weight and N uptake. The residue was as effective in increasing fresh fruit yield, total dry weight, and N uptake as was 4.4 to 7.9 g/plant of N fertilizer. Tomato yield and N uptake per unit amount of N supplied was greater for the residue than for N fertilization.

Two field experiments were conducted in Egypt by Awad *et al.* (2001) to study the effect of intercropping parsley and demsisa with tomato under 4 rates of N fertilizer (100, 120, 140 and 160kg N/fed). The results showed that increasing N fertilizer rate enhanced total yield and net assimilation rate of both mono and mixed crops, earliness index of tomato and NPK uptake of tomato in NAR, total yield, earliness index and total N uptake. The best values were obtained by pure stand planting at the highest N rate (160 kg N/fed), whereas the best P and K uptake were attained at 140and 120 kg N/fed, respectively. The highest value of N supplementation index for tomato was obtained at 100 kg N/fed, where as the highest value of phosphorus supplementation index and Potassium supplementation index were recorded by plants which received 160 kg N/fed.

Tomato cv. Pusa Gaurav was treated with N at 0, 40, 80, and 120 kg/ha and K at 0, 30 and 60 kg/ha in a field experiment conducted in Madhya Pradesh, India during rabi 1992-93 and 1993-94 by Gupta and Sengar (2000). N application resulted in increases in plant height, number of fruits per plant, fruit weight and fresh yield. Increasing N rate produced a corresponding increase in yield and yield components, except total soluble solids (TSS) content. K increased vegetative growth, yield and TSS content.

Hoffland et al. (1999) conducted an experiment on tomato plants with varying N availability were grown by adding N daily in experimentally increasing amounts to a nutrient solution at different rates. Leaves of plants grown at low N availability had a high leaf C: N ratio (21 g/g). The level of soluble carbohydrates correlated positively with susceptibility on, independent of the growth method. It is therefore suggested that the effect of nitrogen availability on susceptibility can be explained by variation in levels of soluble carbohydrates which hence may play a role in the infection process.

In a study on the effect of nitrogen fertilization and plant intensification, Midan *et al.* (1985) observed that increasing nitrogen rates linearly increased the number of fruits per plant. However medium and higher nitrogen rates gaves best total yields. With different nitrogen rates, three time of application improved fruit per plant, weight and total yield. Patil and Bojappa (1984) conducted an experiment to study the effects of cultivars and graded levels of nitrogen and phosphorus of certain quality attributes of tomato. The experiments consisted of the cultivars Pusa Ruby, Sious and Sweet-72. The plant received nitrogen at 70, 110 and 150 kg /ha phosphorus at 44 or 61.6 kg/ha with basal dressing of potassium at 49.8 kg/ha and FYM at 25 t/ha. The highest fruit content of total sugars and next highest dry matter content were in sweet-72 while juice percentage has highest in pusa roby. Raising nitrogen rates increased fruit, total sugars and juice percentage but decrease the dry matter content. Phosphorus had no appreciable effect as any of the indices studied.

Kaya *et al.* (2001) conducted an experiment with three tomato cultivars were grown hydroponically in a controlled temperature room for 6 weeks to investigate the effectiveness of foliar application of supplementary potassium and phosphorus to the leaves of plant grown at high NaCl concentration (60 mM). supplementary 5 mM K and P as KH_2PO_4 was supplied via leaves to the plants grown at high NaCl (60 mM) twice a weeks for 4 weeks. The plants grown at high NaCl produce less dry matter and chlorophyll than those at normal nutrient solution for all three cultivars. Membrane permeability increased with NaCl application and these increases in membrane permeability were decreased by supplementary K and P. Concentrations of P and K were at deficient ranges in the plants grown at high NaCl levels and these deficiencies were corrected by supplementary K and P application via leaves.

Bar Yosef (1995) conducted an experiment of nutrient uptake and dry matter production by a greenhouse tomato (cv-144) crop was investigated in response to the concentration of (0, 10, 30 and 60 mg P/liter) in the liquid feed chemical properties. The leaf Phosphorus content and dry matter production were increased significantly with increasing applied phosphorus. With increasing Phosphorus concentration in leaves, there was an increase in leaf nitrogen and a decrease in potassium that become more pronounced above .65g p/100g plant dry weight. With dry matter production, there was a marked fall-off below a leaf P concentration of 0.3 g p/ 100g plant dry weight.

Garton and Widders (1990) carried out an experimentsnon seedlings of processing tomato cv. H 2653 were grown in plug trays in a soilless growing medium. Application of nutrient solutions containing 10 or 20 mM N and 2 or 5 mM P for 10 days before transplanting alter the total ammoniacal N and P, and the NO_3 Nitrogen and PO_4 Phosphorus concentrations in the shoot tissue at transplanting. Post- transplanting shoot and root growth were more rapid in late may planting than in early plantings. The 20 mM N and 2 mM P pre- transplant treatment cause the most rapid shoot growth following early season planting in the field at harrow. Rapid seedling establishment after transplanting was generally not a good indicator of potential fruit yield. Withholding fertilizer temporarily before transplanting resulted in depletion in tissue N and P concentrations, slow post-transplanting shoot growth, and lower yields.

Tomato cv. Hisar Arun and okra cv. Pusa sawani were planted during the 1991-92 and 19192-93 seasons at Haryana Agricultural University as a crop after potato by Taya et al. (1994).The preceding potato crop received either the recommended fertilizer regime of 150 kg N/ha, 50 kg P_2O_5 /ha and 100 kg K_2O/ha (F_1). The subsequent crops received either N fertilizer at 0 (N_0), 25 (N_1), 50 (N_2) of the recommended rate or 100kg N/ha, 50 kg P_2O_5/ha and 50kg K_2O/ha (NPK). The F_1 treatments increased plant height at 90 days after planting, fruit no. and yield in the subsequent crops of tomato and okra; the F_1 treatments also increased the NPK content of foliage, and delayed flowering in both crops. With the tomato crops there were no significant differences in fruit no. and yield. Leaf n concentration increased with increasing N rate; N application had no effect on leaf P and K content.

Field experiment were conducted on at Uttaranchal, India, by Singh *et al.* (2004) to determine the effect of integrated nutrient management on crop nutrient uptake and yield under okra-pea-tomato cropping sequence, treatments were given to okra crop, while in the succeeding crops (pea and tomato), only recommended dose of fertilizers were applied on the basis of soil test. The treatment consisted of NPK recommended dose of 80:30:30 kg /ha (T_1); farmyard manure (FYM) at 15 tones/ha + rest of the NPK (T_2); neem cake at 3 q/ha + rest of the NPK (T_3); poultry manure at 3 tones /ha + rest of the NPK (T_4); Azospirilum + 75 % N + recommended dose of P and K (T_5); vesicular arbuscular mycorrhizas (VAM) + 50% p + recommended dose of N and K (T_6); phosphate solubilizing bacteria (PSB) + 75% P + recommended N and K (T_7); Azospirilum + VAM + PSB + rest of the NPK (T_8); micronutrient + recommended dose of NPK (T_9); FYM+ Azospirilum + VAM + PSB + rest of the NPK (T_{10}); and recommended dose of NPK + pea straw incorporation in the soil before tomato planting (T_{11}). In the case of okra and pea crops, only the recommended dose of NPK as given in $T_{11.}$ Treatments were applied in the first crop and their effect was observed on instant as well as succeeding crops. The integrated use of organic and inorganic sources of nutrients and biofertilizers increased the N, P and K concentration in the plants of okra, pea and tomato. The integrated nutrient management also significantly increased shoot dry matter yield of tomato and fruit yield of okra and tomato.

A field study was undertaken in Peshawar, Pakistan in the summer of 1995-96 by khalil et al. (2001) to determine the appropriate nitrogen fertilizer for maximum tomato yield and its effects on various agronomic characteristics of tomato. Treatments comprised; untreated control; 150 kg ammonium nitrate/ha + 100 kg P/ha + 50 kg K/ha; 150 kg ammonium sulfate/ha + 100 kg P/ha + 50 kg K/ha; 150kg urea/ha + 100 kg P/ha + 50 kg K/ha. Generally ammonium sulfate fertilizer was the most efficient source of nitrogen for tomato production, followed by urea and ammonium nitrate. The ammonium sulfate +P +K treatment was the best among all treatments with respect to days to flower initiation (57days), days to first picking (94 days), weight of individual fruit (50.8g), weight of total fruit per plant (1990 g) and yield (21865 kg /ha). The control resulted in the significantly lowest response with respect to different agronomic characters under study.

Mohanty and Hossain (2001) conducted a field experiments during robi 1994/95, 1995/96 and 19996/97 at Bhawanipantna, Orissa, India to investigate the effect of nitrogen, potash, and micronutrient application on the yield and yield attributes of tomato. Twelve different treatment combinations were tested and data were recorded or fruit yield attributes weight, and benefit-cost ratio. Two treatment were found superior over other treatments and gave the highest yields with high benefit-cost ratio over the three year study period: (i) 180kg N/ha+ 60 kg P/ha + 60 kg K/ha with top dressing of N twice at 30 and 60 days after planting (Dap); and (ii) 120 kg N/ha + 60 kg P/ha + 60 kg K/ha with top dressing of N twice at 30 and 60 days after planting (Dap) along with two sprays of micronutrients at flowering and 15 days thereafter.

Felipe and Casanova (2000) carried out an experiment to determine the effects of N (0, 90, 180 and 270 kg/ha), P (P_2O_5, 0, 135, 270 and 405 kg/ha), and K (K_2O, 0, 90,180 and 270 kg/ha) on the yield and number of fruits of tomato were investigated in the field in Venezuela. The best treatment, with the highest yield and number of fruit per plant, was 180 kg N, 270kg P_2O_5 and 180 kg K_2O/ha. It was possible to decrease the application of nutrients, particularly P. The increased yield is not due large fruits, but to a number increase in the number of fruits. N had a profound effect on the number of fruits.

A field experiment was conducted by Sharma et al. (1999) with involving of 4 levels of N (100, 150, 200 and 250 kg/ha), 3 levels of P (60,120 and 180 kg P_2O_5 /ha) and 3 tomato hybrids (Naveen, MTH-16 and Rupali) had a local cultivar (Solan Gola) was conducted at Solan,India, to study the response of tomato hybrids N and P. All the hybrids were giving the significantly higher total fruit yields than the local cultivar. Naveen recorded the greatest total fruit yield, while remaining statistically at par with Mth-16 and Rupali. Application of 200 kg N/ha resulted in significantly greater fruit size and mean fruit weight, compared to other application rates. A significant improvement in plant height, fruit size and total fruit yield was observed with the application of P from 60 to 180 kg P_2O_5/ha.

Cerne and Briski (1993) conducted field trials on the fertilizer and irrigation requirement of tomato cv. Rudgers plants where 250 kg and 72 kg P_2O_5/ha plus 200 or 400 kg K_2O/ha in the first year, 0, 0r 200 kg K_2O/ha in the second year and 0 or 40 ton stable manure/ha were received all treatments. Plots were irrigated or non-irrigated (i.e. rain fed only). The combination of 400kg K_2O/ha, stable and irrigation gave the highest yield in the first and second years (1.03 and 2.25 kg /plant respectively). The percentages of class 1 fruit were increased by irrigation in all class.

The effects of adding Zn (5 kg/ha), cu (3kg/ha) or FYM (30t/ha) to the basis N: P: K (222:160:100 kg/ha) treatment as leaf transpiration and chlorophyll content and fruit ascorbic acid and sugar content were studied by Annanurova *et al.* (1992) the treatment was beneficial and the number and mean weight of fruit were increased .Application of NPK alone increased yield/plant 43.4% compared with the untreated control.

While studying the nitrogen, phosphorous and potassium fertility regimens affect tomato transplant growth, Melton and default (1991) found that as nitrogen increased from 25 to 225 mg/liter, fresh shoot weight, plant height, stem diameter leaf number, leaf area shoot and root dry weight and total chlorophyll content of seedlings ready for transplanting increased .Phosphorous of 45mg/liter increased fresh shoot weight, plant height stem diameter leaf number are compared with 5to 15 mg P/liter. Potassium did not significantly influences any of the growth variables measured in the study.

Nileema and Sreeenivasa (2011) conducted an experiment at main Agriculture Research Station, University of Agriculture Sciences, Dharwad to study the influence of liquid organic manures viz., Panchagavya, jeevamruth and beejamruth on the growth, nutrient content and yield of tomato in the sterilized soil during kharif 2009. The various types of organic solutions prepared from plant and animal origin are effective in the promotion of the growth fruiting in tomato.

The Panchagavya is an effective plant growth stimulance that enhances the biological efficiency of crops. It is used to active biological reactions in the soil and to protect the plant from disease incidence. Jeevamruth promotes immense biological activity in soil and enhance nutrient availability of crops. Beejamruth protect the crop from soil borne and seed borne pathogens and also improves seed germination. In the present study, significantly highest plant growth and root length was recorded with the application of RDF + Beejamruth + Jeevamruth + Panchagavya and it was found to be significantly superior over other treatments. The application of Beejamruth + Jeevamruth + Panchagavya was next best treatment and resulted in significantly highest yield as compared to RDF alone.

Oikeha and Asiegbu (1993) conducted an experiment where 4 types of organic manures and NPK fertilizer, each at 4 rates, were assessed under field conditions for their comparative effects on the growth and yield of tomato. Tomato fruit yields (49 and 47 t/ha) was best with swine and poultry manure applied at the rate of 10 t/ha. Yields of 42 and 47 t/ha were obtained at sewage sludge or rabbit manure applied at rate of 20 t/ha, while with NPK the best yield (35 t/ha) was obtained with formulation of N 100, P 40 and K 100kg/ha. Application of higher amount of manure (30 t/ha) depressed growth and yield, irrespective of the manure source. The potential fertilizer values of the organic manures are not fully reflected by early growth parameters as they were with NPK treatment, apparently due to slow release of elements that were still bound in organic forms of manures. The ultimate yield advantages associated with organic manures compared with NPK fertilizer were, in part, ascribed to their probable effects on the soil physical characteristics, and their supply of macro and micronutrient elements not contained in NPK fertilizer.

Sathish *et al.* (2009) carried out an experiment to evaluate biological activity of organic manures against tomato fruit borer, *Helicoverpa armigera* (Hub) and safety of otanicals and biopesticides against egg parasitoid, *Trichogramma chilonis ishii* and biological effects of *Pseudomonas flurescens* on tomato under pot culture conditions. The feeding and infestation of larvae of *Helicoverpa armigera* were significantly low in FYM, Azospirillum + Silicate Solubilising Baccteria (SSB) + Phosphobacteria + neem cake applied plants followed by FYM + Azospirillum + Silicate Solubilising Baccteria (SSB) + Phosphobacteria + mahua applied plants. *Trichogramma parasitization* on *Helicoverpa armigera* eggs was adversely affected by neem oil 3% on treated plants followed by neem seed karnel extract 5% + Spinosad 75 g a.i/ha, HaNPV + Spinosad + bt (1.5 × 1012 POBs/ha + 75 g a.i/ha + 15000 IU/mg^{-2} lit/ha), Spinosad +Bt (75 g a.i/ha + 15000 IU/mg^{-2} lit/ha) showed higher insecticidal toxicity (100 percent mortality on 72 h) to all instars of *Helicoverpa armigera* larvae. Biochemical parameter like phenol content, peroxidase and phenyl alanine ammonialyase (PAL) activity recorded higher levels in *Pseudomonas flurescens* seed treatment @ 30 g/kg of seed and its foliar spray @ 1 g/liter in treated tomato plants.

Handa et al. (2001) was conducted a field trails where using different fertilizers having equal concentration of nutrients to determine the impact of different growth parameters of tomato plants. Six types of experimental plots were prepared where T_1 was kept as control and five others were treated by different category of fertilizers (T_2- Chemical fertilizer, T_3- FYM, T_4- Vermiccompost, T_5 and T_6- FYM supplemented with chemical fertilizers and vermicompost respectively). The treatment plots T_6 showed 73% better yield of fruits than control, Besides, Vermicompost supplemented with NPK treated plots T_5 displayed better results with regards to fresh weight of leaves, dry weight of leaves, dry weight of fruits, number of branches and number of fruits per plant from other fertilizer treated plants.

In a performance trials of six varieties of tomato conducted at the Bangladesh Research Institute, Joydebpur Hossain and Ahmed (1973) observed that cv. Sanmarzano was the highest yielder (28.98 t/ha), followed by Oxheart, Roma, Bulgeria, USA and Anabik. They also observed that Oxheart produce the longest fruits with the average weight of 87 g followed by Bulgeria, Roma, USA and Anabik and Sanmarzano.

Norman (1974) carried out an experiment to observe the performance of 13 varieties of tomato in Ghana. He found significant differences between cultivars in plant height, fruit maturity, yield and quality. He also started that in the dry season, Floradel, Ace VF, Floralon, Piacenza 0164, red color and Ife no. 1 were found to be high yielder and appeared promising.

A field trial was conducted at the vegetable Division of Bangladesh Research Institute, Joydebpur, Dhaka, in 1969-70, with 5 varieties of tomato (Oxheart, Sinkurihara, I-7, Marglobe and Bulgeria). The experiment was repeated in 1971-72. In both years, the varieties Oxheart and Sinkurihara were found to similar and significantly higher yielder than the others (Hque *et al.*)

An experiment was conducted with two summer tomato varieties (BINA tomato 2 and BINA tomato 3) to study the yield performance at 3 locations of Bangladesh (Magura, Comilla and Khulna) during the summer season (BINA, 1998). It was observed that BINA tomato 2 produced higher fruit yield at Magura (38 t/ha) and Khulna (17 t/ha), while BINA tomato 3 produced higher fruit yield (29 t/ha) at Comilla. However mean fruit yield from 3 locations showed that, the variety BINA tomato 2 produced higher fruit yield than BINA tomato 3).

Gupta and Sengar (2000) conducted experiments with tomato cv. Pusa Gaurav treated with N at 0, 40, 80, and 120 kg/ha and K at 0, 30, and 60 kg/ha in a field experiment in Madhya Pradesh, India during *rabi* 1992-93 and 1993-94. N application resulted in increases in plant height, number of fruits per plant, fruit weight and fresh yield. Increasing nitrogen produced a corresponding increase in yield and yield component, except total soluble solids (TSS) content. K increased vegetative growth, yield and TSS content. Increasing K rate up to 60 kg/ha increased growth parameters like plant height, and also increased fruit weight and marketable yield.

Chapter 3

Materials and Methods

Chapter 3

MATERIALS AND METHODS

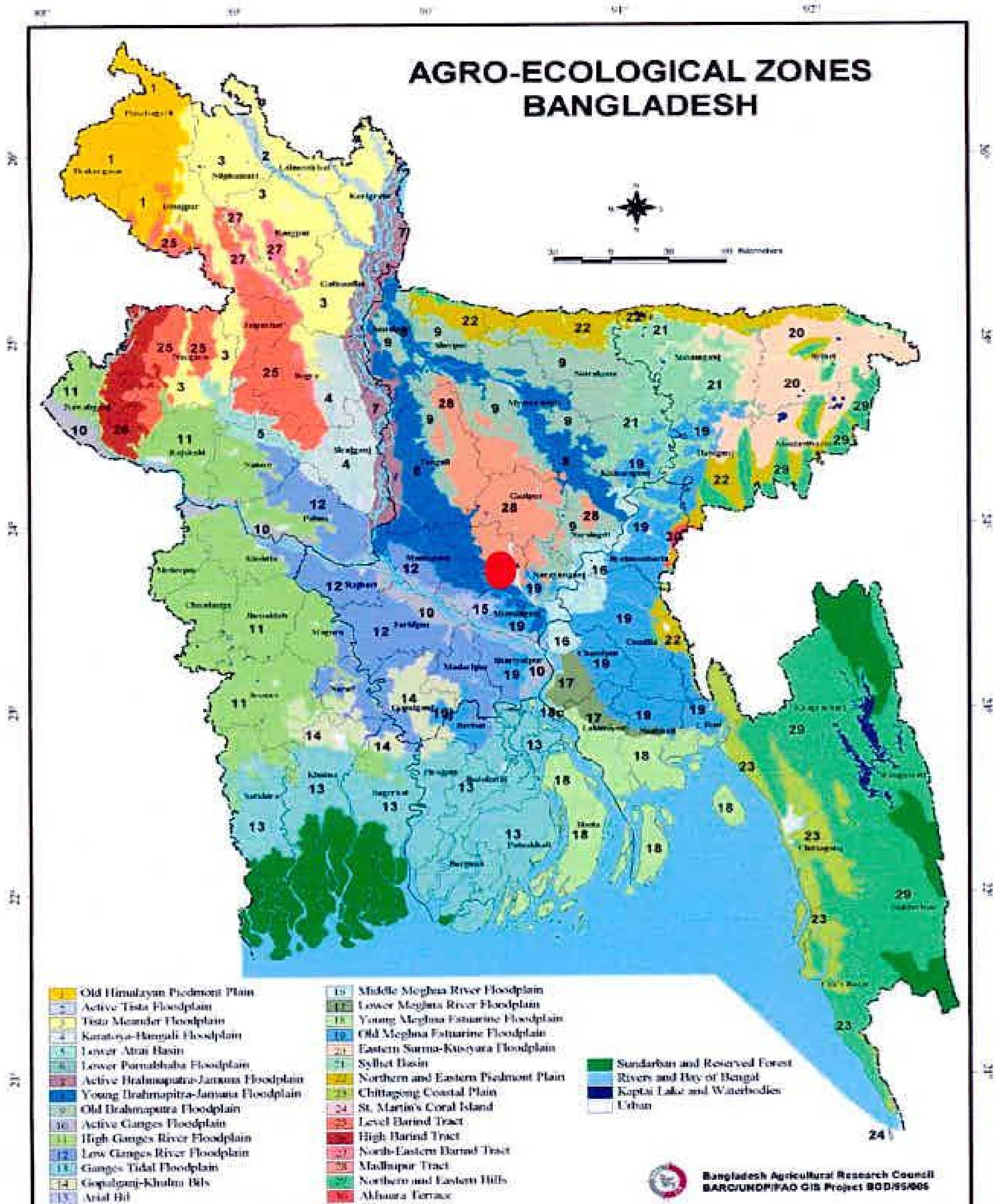
The experiment was conducted at the Research farm of Sher-e Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during November 2011 to March 2012 to examine the effect integrated nutrient management on the yield and performance of tomato.

3.1 Experimental Site

The experiment was carried out at Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, and Dhaka, Bangladesh. The location of the experimental site is $23^{0}77'$ N latitude and $90^{0}3'$ E longitude of an elevation of 1 meter above the sea level (Fig. 1).

3.2. Characteristics of soil

The soil of the experimental site belongs to Tejgaon series under the Agro-ecological Zone, Madhupur Tract (AEZ – 28), which falls under Deep Red-Brown Terrace soil. Soil samples were collected from the experimental plot to a depth of 0-15 cm from the surface before initiation of the experiment and analyzed in the laboratory. The morphological characteristics of the experimental field and physical and chemical properties of initial soil are shown in Table 1 & 2, respectively.



Experimental Site under study

Fig. 1. Map showing the experimental site under study

Tablel. The morphological characteristics of the experimental field

Morphological Features	Characteristics
Location	Sher-e-Bangla Agricultural University Farm, Dhaka-1207
AEZ No. and Name	AEZ – 28, Madhupur Tract
General Soil type	Deep Red Brown Terrace soil
Soil Series	Tejgaon
Topography	Fairly leveled
Depth of Inundation	Above flood level
Drainage condition	Well drained
Land type	High land

Table2. Physical and chemical properties of the experimental soil

Soil Properties		Value
A. Physical Properties		
1. Particle size analysis of soil		
% Sand		31.50
% Silt		39.34
% Clay		29.16
2. Soil texture		Silty Clay Loam
B. Chemical Properties		
1.	Soil pH	5.8
2.	Organic Carbon (%)	0.57
3.	Organic matter (%)	0.98
4.	Total N (%)	0.07
5.	Available P (ppm)	25.0
6.	Exchangeable K (me/100g soil)	0.15
7.	Available S (ppm)	20.0

3.3. Weather condition of the experimental site

The experimental area has sub tropical climate characterized by heavy rainfall during May to September and scant rainfall during rest of year. The annual precipitation of the site is 2152 mm and potential evapotranspiration is 1297 mm. The average maximum temperature is 30.34^0 C and average minimum temperature is 21.21^0 C. The average mean temperature is 25.17^0 C. The experiment was done during the robi season. Temperature during the cropping period ranged between 12.20^0C to 29.2^0C. The humidity varies from 71.52 % to 81.2 %. The day length was reduced to 10.5- 11.0 hours only and there was a very little rainfall from the beginning of experiment to harvesting (Appendix- I).

3.4. Planting Materials

BARI Tomato-2 (*Lycopersicon esculentum)*, a variety released by BARI. Local name of this variety is Ratan. Seedlings were collected from Horticultural farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

3.5. Treatment of the experiment

The treatments are as follows:-

T_1 180 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP (Only inorganic)

T_2 155 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 25kg N/ha from Cow dung (Integrated)

T_3 130 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 50kg N/ha from Cow dung (Integrated)

T_4 105 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 75kg N/ha from Cow dung (Integrated)

T_5 80 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 100kg N/ha from Cow dung (Integrated)

T_6 55 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 125kg N/ha from Cow dung (Integrated)

T_7 30 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 150kg N/ha from Cow dung

T_8 180kg N/ha from Cow dung (only organic)

T_9 Control

There were 27 (9 × 3) treatment combinations such as T_1R_1, T_1R_2, T_1R_3, T_2R_1, T_2R_2, T_2R_3, T_3R_1, T_3R_2, T_3R_3, T_4R_1, T_4R_2, T_4R_3, T_5R_1, T_5R_2, T_5R_3, T_6R_1, T_6R_2, T_6R_3, T_7R_1, T_7R_2, T_7R_3, T_8R_1, T_8R_2, T_8R_3, T_9R_1, T_9R_2 and $T_9 R_3$.

3.6. Design and layout of the experiment

The experiment was laid out in a Randomized Complete Blok Design RCBD) with three replications of each fertilizer treatment combinations. Fertilizer treatments consisted of 9 levels of N and single level of P & K on the growth and yield of tomato. An area 12m × 23m was divided into 3 equal blocks. The layout of the experiment was prepared for distributing the treatment combinations into the every plot of each block. Each block was divided into 9 plots where 9 treatment combinations were allotted at random. There were 27 unit plots altogether in the experiment. The size of the each plot was $6m^2$ (3 m × 2 m). The distance maintained between two blocks and two plots were 1 m and 0.5 m respectively. The layout of the experiment is shown in Figure 2.

3.7. Collection and preparation of initial soil sample

Soil samples from the experimental field were collected before land preparation to a depth of 0-15 cm from the surface on the basis of composite sampling method. The collected soil was air dried ground and passed through a 2 mm sieve and stored in a clean, dried plastic container for physical and chemical analysis.

3.8. Land Preparation

The land which was selected to conduct for the experiments was opened by a disc plough on 25 November, 2011 to open direct sunshine to kill soil borne pathogens and soil inhabitant insect .The land was level. The weeds, crop residues and stables were removed from the field. After final land preparation the experimental plot was laid out, and the edge around each unit plot was raised (20 cm high) to check run out of the nutrients. The land preparation was completed at 27 November.

3.9. Application of manure and fertilizer

The sources of N, P_2O_5, K_2O as urea & cow dung, TSP and MoP were applied, respectively. The entire amounts of well rotten cow dung, TSP and Mp were applied during the final land preparation. As per treatment combination Urea was applied in three equal installments at 15, 30 and 45 days after seedling transplanting.

3.10. Transplanting of seedling

Healthy and uniform sized 30 days old seedlings were uprooted from the seed bed and were transplanted in the experimental field on 25 November, 2011 maintaining a spacing of 60 cm and 55 cm between the rows and plants respectively. The seed bed was watered before uprooting the seedling so as to minimize the damage of the roots. The seedlings were watered after transplanting. Shading was provided by banana leaf sheath for three days to protect the seedlings from the direct sun. A strip of the same crop was established around the experimental field as border crop to do gap filling and to check the border effect.

3.11. Gap-filling and weeding

When the seedlings were established, the soil around the base of each seedling was pulverized. A few gaps filing were done by healthy plants from the border whenever it was required. Weeds of different types are enrolled manually and removed from the field on 17 December 2011. Second and third weeding were done on 31 December, 2011 and 20 January, 2012, respectively.

3.12. Irrigation

Irrigation was applied at several times. After transplanting of seedlings, water was applied by water can one day interval up to 15 days to establish the seedling properly. On 18 December 2011 at 20 days after transplanting (DAT) irrigation was applied through irrigation cannel. It was repeated after every 5 day interval Irrigation was also applied at the stage of maximum vegetative growth stage (35 DAT), on 2 January, 2012, and at the stage of fruit formation (55 DAT) on 22 January, 2012.

3.13. Pest management

For controlling leaf caterpillars, nogos @ 1ml/l water were applied 2 times at an interval of 10 days starting soon after the appearance of infestation. There was no remarkable attack of disease was found.

3.14. Harvesting

Fruits were harvested at 5 days intervals during maturity to ripening stage. The maturity of the crop was determined on the basis of red coloring of fruits. Harvesting was started from 6 March, 2012 and completed by 29 March, 2012.

3.15. Collection of experimental data

Five (5) plants from each plot were selected randomly and were tagged for the data collection. The sample plants were uprooted and dried properly in the sun. Data were collected on the following parameters:

1) Plant height per plot
2) Number of leaf per plant
3) Number of fruit per plant
4) Yield per plot (kg)
5) Yield per hectare (t)
6) Nutrient status (N, P, K and S), organic matter content and pH of post harvest soil and initial soil.

3.16. Methods of Soil Analysis

1) Particle size analysis of soil

Particle-size analysis of the soil was done by hydrometer method (Bouyoucos, 1927). The textural class was determined using Marshall's Triangular Co-ordinate as designated by USDA.

2) Organic carbon (%)

Organic carbon of soil was determined by Walkley and Black's (1934) wet oxidation method. The underlying principle is to oxidize the organic carbon with an excess of 1 N $K_2Cr_2O_7$ in presence of conc. H_2SO_4 and to titrate the residual $K_2Cr_2O_7$ solution with 1 N $FeSO_4$ solution. The result was expressed in percentage.

3) Soil organic matter

Soil organic matter content was calculated by multiplying the percent value of organic carbon with the van Bemmelen factor, 1.724 as described by Piper (1942).

% organic matter = % organic carbon × 1.724.

4) Soil pH

The pH of the soil was determined with help of a glass electrode pH meter using soil: water ratio being 1: 2.5 (Jackson, 1973).

5) Total nitrogen (%)

Total nitrogen content in soil was determined by Kjeldahl method by digesting the soil sample with conc. H_2SO_4 , 30% H_2O_2 and catalyst mixture (K_2SO_4 : $CuSO_4$. $5H_2O$: Se = 10 : 1 : 0.1) followed by distillation with 40% NaOH and by titration of the distillate trapped in H_3BO_3 with 0.01 N H_2SO_4 (Black, 1965).

6) Available Phosphorus (ppm)

Available Phosphorus was extracted from soil shaking with 0.5 M $NaHCO_3$ solution of pH 8.5 (Olsen *et al.* 1954). The phosphorus in the extract was than determined by developing blue color using $SnCl_2$ reduction of phosphomolybdate complex. The absorbance of the molybdatephosphate blue color was measured at 660 nm wave length by spectrophotometer and available P was calculated with the help of standard curve.

7) Available Sulphur

Available Sulphur in soil was determined by extracting the soil sample with 0.15 % $CaCl_2$ solution (page *et al.,* 1982). The S content in the extract was determined turbidimetrically and the intensity of turbid was measured by spectrophotometer at 420 nm length.

3.17. Methods of Pant Analysis

For determination of N, P, K and S content in plants the sample was first digested with acid. For N digestion was done with conc. H_2SO_4 and digest was distilled following the procedure outlined under Soil Analysis section (3.16). An amount of 0.5g of plant was taken into a dry clean 100 ml Kjeldahl flask, 10 ml of di-acid mixture (HNO_3 and $HClO_4$ at the ratio of 2: 1) was added and kept for few minutes. Then, the flask was heated at a temperature raising slowly up to 200^0 C. Heating was instantly stopped as soon as the dense white fumes of $HClO_4$ occurred and after cooling, 6 ml of 6N HCl were added to it. The content of the flask was boiled until they become clear and colorless. This digest was used for determining p, K, S and Zn.

3.18. Statistical Analysis

The collected data were statistically analyzed by using the ANOVA technique. The test of significance of all parameter was done. The Duncan's multiple Range Test (DMRT) with Least Significant Difference value was determined with appropriate levels of significance and the means were tabulated. The mean comparison was carried out by DMRT technique (Gomez and Gomez, 1984).

Chapter 4

Results and Discussion

Chapter 4

RESULTS AND DISCUSSIONS

This chapter includes the experimental results along with discussions. Effect of integrated nutrient management on plant height, number of leaf per plant, number of fruit per plant, yield per plot (kg), yield per hectare (t), N, P and S content in tomato plants and N, P & S content in post harvest soil shown in the Tables 3-6. The results presented in tables are discussed character wise under the following heads.

4.1 Effect of integrated nutrient management on growth and yield of tomato

4.1.1 Plant height

Integrated effect of organic manure and inorganic fertilizers on Plant height of tomato was significantly increased by different levels of nitrogen (Table 3). The tallest plant (67.03 cm) was produced with 80 kg N/ha from Urea which was statistically similar with that of 105 kg N/ha from Urea followed by 55 kg N/kg from Urea and shortest plant (47.50 cm) was found in control treatment. It was observed that plant height increased gradually with the increasing of nitrogen doses up to 105 kg N/ha from Urea. This might be due to higher availability of N and their uptake that progressively enhanced the vegetative growth of the plant. These are in agreement with those of Ali *et al*. (1990), Mondal and Gaffer (1983), Gaffer and Razzaque (1983), who have reported that different levels of nitrogen significantly increased plant height.

4.1.2. Number of leaf per plant per plot

Integrated effect of organic manure and inorganic fertilizers exhibited a significant influence on number of leafs per tomato plant (Table 3). The maximum number (98.89) of leaves per plant was obtained from T_4 treatment, while the minimum (61.59) was obtained from control treatment. It was observed that the application of N up to 105 kg/ha from Urea increased number of leafs per plant. Further addition of N decreased the number of leafs per plant. The reports recorded by other investigators such as Jgadeesha (2008) and Sathish *et al.* (2009).

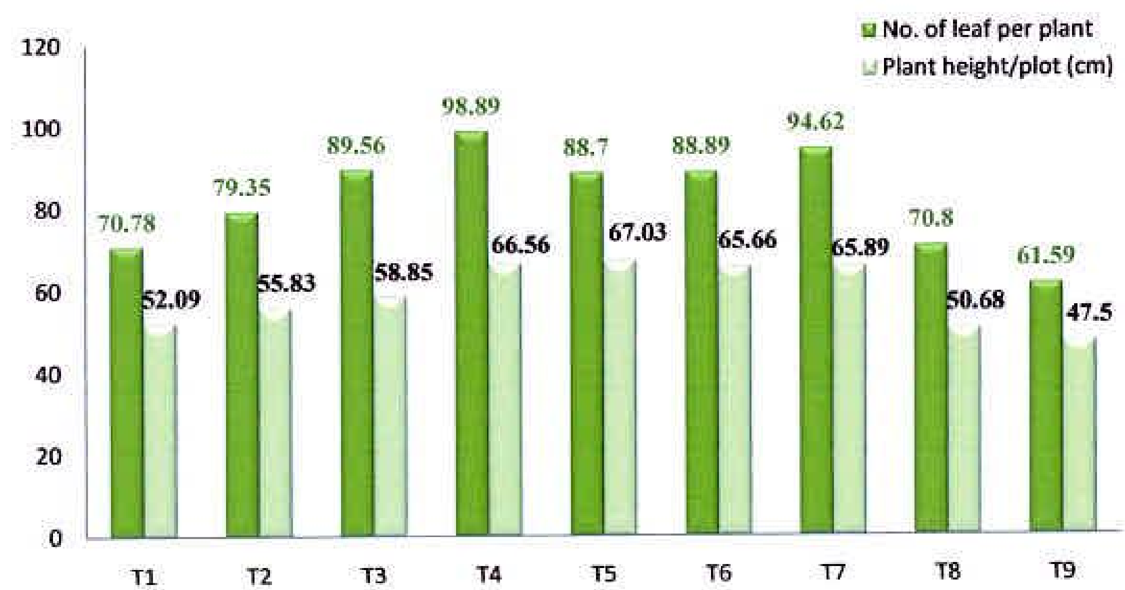


Fig. 3: Integrated effect of organic and inorganic fertilizer on plant height and number of leaf per plant per plot of tomato

T_1= 180 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP (Only inorganic)

T_2= 155 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 25kg N/ha from Cow dung (Integrated)

T_3= 130 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 50kg N/ha from Cow dung (Integrated)

T_4= 105 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 75kg N/ha from Cow dung (Integrated)

T_5= 80 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 100kg N/ha from Cow dung (Integrated)

T_6= 55 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 125kg N/ha from Cow dung (Integrated)

T_7= 30 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 150kg N/ha from Cow dung

T_8= 180kg N/ha from Cow dung (only organic)

T_9= Control

Table 3. Integrated effect of organic and inorganic fertilizer on plant height and number of leaf per plant per plot of tomato

Treatment	Plant height/plot (cm)	Number of leaf per plant
T_1	52.09d	70.78e
T_2	55.83c	79.35d
T_3	58.85b	89.56c
T_4	66.56a	98.89a
T_5	67.03a	88.70c
T_6	65.66a	88.89c
T_7	65.89a	94.62b
T_8	50.68d	70.80e
T_9	47.50e	61.59f
SE±	1.43	2.33
CV(%)	2.43	2.82
LSD	3.42	5.12

** = Significant at 1 % level of probability

T_1= 180 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP (Only inorganic)

T_2= 155 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 25kg N/ha from Cow dung (Integrated)

T_3= 130 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 50kg N/ha from Cow dung (Integrated)

T_4= 105 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 75kg N/ha from Cow dung (Integrated)

T_5= 80 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 100kg N/ha from Cow dung (Integrated)

T_6= 55 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 125kg N/ha from Cow dung (Integrated)

T_7= 30 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 150kg N/ha from Cow dung

T_8= 180kg N/ha from Cow dung (only organic)

T_9= Control

4.1.3. Number of fruit per plant

Integrated effect of organic manure and inorganic fertilizers on number of fruit per plant was significant (Table 4). Number of fruits per plant gradually increased with increasing levels of nitrogen up to 105 kg N/ha. The highest number of fruits per plant (67.07) was obtained with the application of 80 kg N/ha from Urea + 100 kg N/ha from CD, which was statistically different from other treatments. The lowest number of fruits per plant (38.51) was produced by control treatment. It was observed that the application of N up to 105 Kg/ha from Urea increased number of fruits per plant. Further addition of N decreased the number of fruit per plant. Sharma (1995) found height number of fruit per plant with 120 kg N/ha.

4.1.4. Yield per plot (kg)

Integrated effect of organic manure and inorganic fertilizers on weight of fruit per plant varied significantly due to the application of different levels of N in tomato under the present experiment (Table 4). Fruit weight per plant increased with increasing levels of N up to 105 kg/ha from Urea. Further addition of N above 105 kg/ha from Urea decreased fruit yield per plot of tomato. The highest fruit yield per plot (46.43 kg) was obtained in T_5 treatment and the lowest fruit yield per plot (26.66 kg) was recorded in control treatment. Chung et al. (1992) reported that increasing levels of nitrogen increased the fresh weight of tomato fruit.

4.1.5. Yield per hectare (ton)

Integrated effect of organic manure and inorganic fertilizers on fruit weight per plot of tomato was significantly affected by different levels of nitrogen (Table 4). Plant receiving N at the rate of 105 kg/ha N from Urea +75 kg N/ha from CD gave significantly higher yield (77.39 t/ha), which was statistically similar with the treatment receiving 80 kg N/ha from Urea +100 kg N/ha from CD. The lowest weight of fruit per plot (44.43 t/ha) was recorded in control treatment.

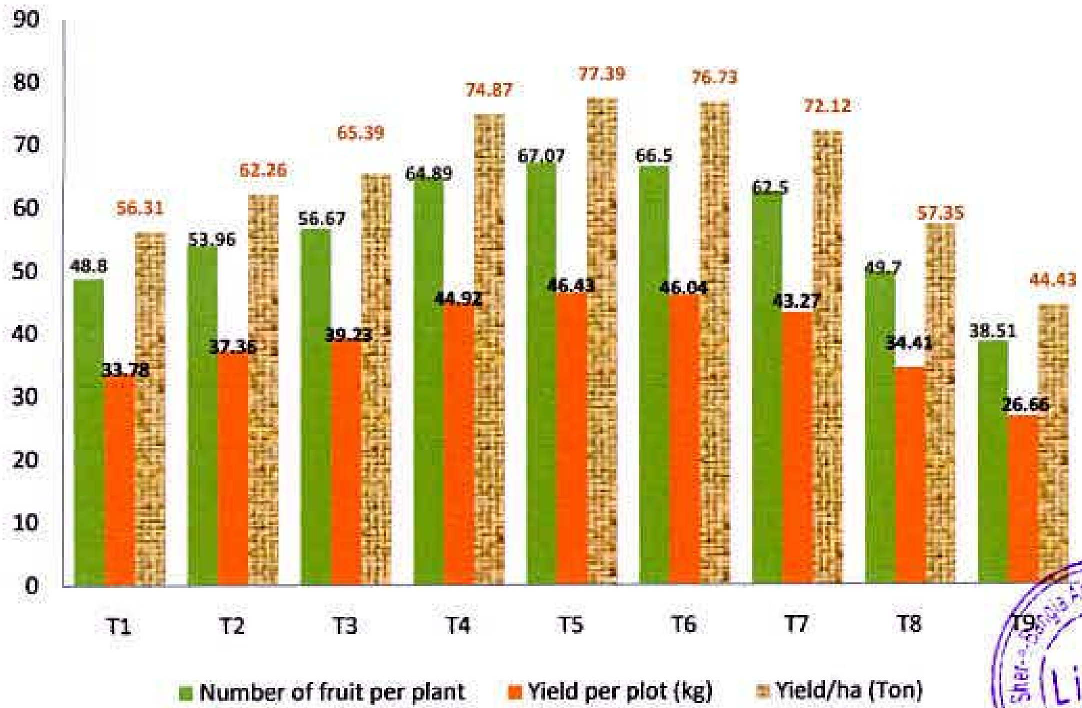


Fig. 4: Integrated effect of organic and inorganic fertilizer on number of fruit per plant, yield per plot (kg) and yield per hectare (t)

T_1= 180 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP (Only inorganic)

T_2= 155 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 25kg N/ha from Cow dung (Integrated)

T_3= 130 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 50kg N/ha from Cow dung (Integrated)

T_4= 105 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 75kg N/ha from Cow dung (Integrated)

T_5= 80 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 100kg N/ha from Cow dung (Integrated)

T_6= 55 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 125kg N/ha from Cow dung (Integrated)

T_7= 30 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 150kg N/ha from Cow dung

T_8= 180kg N/ha from Cow dung (only organic)

T_9= Control

Table 4. Integrated effect of organic and inorganic fertilizer on number of fruit per plant, yield per plot and yield /ha

Treatment	Number of fruit per plant	Yield per plot (kg)	Yield/ha (Ton)
T_1	48.8f	33.78d	56.31c
T_2	53.96e	37.36c	62.26b
T_3	56.67d	39.23b	65.39b
T_4	64.89b	44.92b	74.87b
T_5	67.07a	46.43a	77.39a
T_6	66.5c	46.04cd	76.73a
T_7	62.5b	43.27d	72.12b
T_8	49.7f	34.41e	57.35c
T_9	38.51g	26.66	44.43c
SE±	1.80	0.35	0.31
CV(%)	3.19	5.39	4.41
LSD	7.21	2.14	0.73

** = Significant at 1 % level of probability

T_1= 180 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP (Only inorganic)

T_2= 155 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 25kg N/ha from Cow dung (Integrated)

T_3= 130 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 50kg N/ha from Cow dung (Integrated)

T_4= 105 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 75kg N/ha from Cow dung (Integrated)

T_5= 80 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 100kg N/ha from Cow dung (Integrated)

T_6= 55 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 125kg N/ha from Cow dung (Integrated)

T_7= 30 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 150kg N/ha from Cow dung

T_8= 180kg N/ha from Cow dung (only organic)

T_9= Control

4.2. Effect of integrated nutrient management on nutrient content in tomato plants and in post harvest soil

4.2.1. Nitrogen content in plants

Data on N content in plant was influenced by N fertilization. Integrated effect of organic manure and inorganic fertilizers on N content of plant was positive and significant (Table 6). The highest N content in plant was 1.63%, which was observed in T_4 treatment. The lowest N content in plant was 0.82%, which was found in control treatment. The result revealed that the N content in plant was increased with increasing rate of nitrogen up to 105 kg/ha from Urea, further addition of nitrogen it was decreased.

4.2.2. Phosphorus content in plants

There was a significant difference found among the different treatments of N in respect of P content in plants (Table 6). Basically we know that phosphorus content is increasing with decreasing rate of nitrogen content in plant. Maximum P content of 0.386% was found in T_1 treatment and the minimum P content of 0.124 % was found in control treatment.

4.2.3. Nitrogen content in post harvest soil

Different level of nitrogen showed a significant variation for total nitrogen in soil under the present trial (Table 6).The maximum total nitrogen (0.081%) was recorded from T_1 and the minimum total nitrogen (0.05%) in soil is recorded from T_8 treatment (Table 6.)

Fig. 5: Integrated Effect of organic and inorganic fertilizer on nutrient content in tomato plant

T_1= 180 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP (Only inorganic)

T_2= 155 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 25kg N/ha from Cow dung (Integrated)

T_3= 130 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 50kg N/ha from Cow dung (Integrated)

T_4= 105 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 75kg N/ha from Cow dung (Integrated)

T_5= 80 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 100kg N/ha from Cow dung (Integrated)

T_6= 55 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 125kg N/ha from Cow dung (Integrated)

T_7= 30 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 150kg N/ha from Cow dung

T_8= 180kg N/ha from Cow dung (only organic)

T_9= Control

Table 5: Integrated Effect of organic and inorganic fertilizer on nutrient content in tomato plant

Treatment	Nutrient content in plant %	
	Nitrogen	Phosphorus
T_1	1.28b	0.386a
T_2	1.301a	0.38ab
T_3	1.313c	0.386bc
T_4	1.63a	0.311cd
T_5	1.60a	0.318de
T_6	1.10c	0.237ef
T_7	0.98cd	0.142f
T_8	0.95cd	0.130f
T_9	0.82d	0.124f
SE±	0.059	0.03
CV(%)	4.79	10.71
LSD	0.02	3.06

** = Significant at 1 % level of probability

T_1= 180 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP (Only inorganic)

T_2= 155 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 25kg N/ha from Cow dung (Integrated)

T_3= 130 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 50kg N/ha from Cow dung (Integrated)

T_4= 105 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 75kg N/ha from Cow dung (Integrated)

T_5= 80 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 100kg N/ha from Cow dung (Integrated)

T_6= 55 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 125kg N/ha from Cow dung (Integrated)

T_7= 30 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 150kg N/ha from Cow dung

T_8= 180kg N/ha from Cow dung (only organic)

T_9= Control

4.2.4. Available Phosphorus content in post harvest soil

Different levels of nitrogen showed a significant variation for available P in soil under the present trial (Appendix V). The highest P content in soil was 25.67%, which was observed in T_4 treatment and it was statistically similar with T_5 and T_2 treatment. The lowest P content in soil was 20.60%, which was found in control treatment (Table 7).

4.2.5. Available Sulphur content in post harvest soil

Different levels of nitrogen showed a significant variation for available S in soil under the present trial. The highest S content in soil was 14.45%, which was observed inT_5 treatment and it was statistically similar with T_6, T_7, T_8 and T_9 treatments. The lowest S content in soil was 12.28%, which was found in T_2 treatment (Table 6).

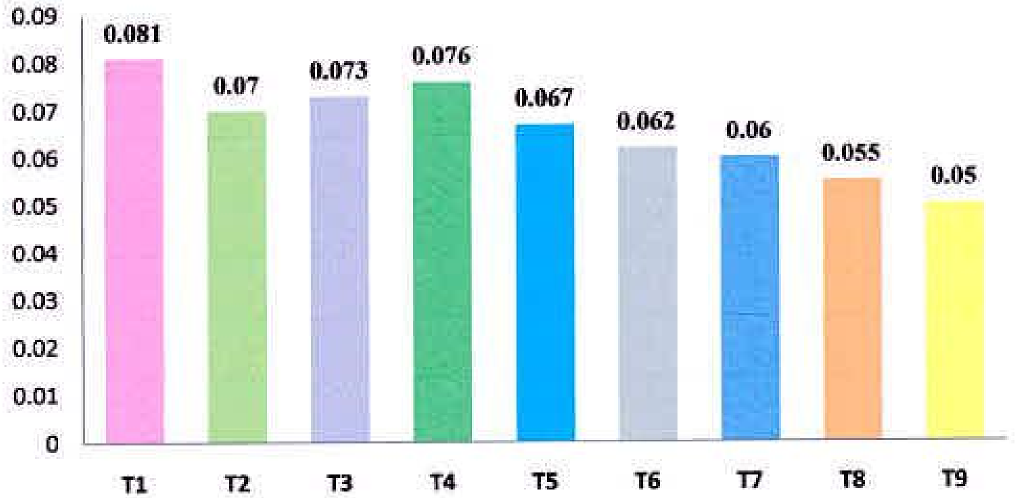


Fig. 6: Integrated effect of organic and inorganic fertilizer on Nitrogen content on post harvest soil

Table 6. Integrated effect of organic and inorganic fertilizer on nutrient content on post harvest soil

Treatment	Nutrient present in post harvest soil		
	Total N (%)	Available P (ppm)	Available S (ppm)
T_1	0.081a	22.60a	12.37bcd
T_2	0.070abc	23.20a	11.28d
T_3	0.073abc	24.01a	12.00bcd
T_4	0.076ab	25.67a	11.80cd
T_5	0.067a-d	24.80a	14.45a
T_6	0.062b-e	23.72a	13.89ab
T_7	0.060cde	22.70a	13.60abc
T_8	0.055de	21.09a	13.58abc
T_9	0.05e	20.60b	12.50abc
SE±	0.002	0.38	0.27
CV(%)	3.37	0.92	2.05
LSD	2.16	0.24	0.20

** = Significant at 1 % level of probability

T_1= 180 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP (Only inorganic)

T_2= 155 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 25kg N/ha from Cow dung (Integrated)

T_3= 130 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 50kg N/ha from Cow dung (Integrated)

T_4= 105 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 75kg N/ha from Cow dung (Integrated)

T_5= 80 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 100kg N/ha from Cow dung (Integrated)

T_6= 55 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 125kg N/ha from Cow dung (Integrated)

T_7= 30 kg N/ha from Urea + 25kg P/ha from TSP + 60kg K/ha from MoP + 150kg N/ha from Cow dung

T_8= 180kg N/ha from Cow dung (only organic)

T_9= Control

Chapter 5

Summary & Conclusion

Chapter 5

SUMMARY & CONCLUSION

The experiment was conducted at the Research farm of Sher-e Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during November 2011 to March 2012 to examine the effect integrated nutrient management on the yield and performance of tomato. The experiment was laid out in a Randomized Complete Blok Design RCBD) with 3 replications of each fertilizer treatment combinations. The unit plot size was 6 m^2(3 m × 2 m). There were 9 treatment combinations in the experiment comprising 9 levels of N (180 kg/ha from Urea , 155 kg/ha from Urea + 25kg/ha from CD, 130 kg/ha from Urea + 50kg/ha from CD , 105 kg/ha from Urea + 75kg/ha from CD, 80 kg/ha from Urea + 100kg/ha from CD, 55 kg/ha from Urea + 125kg/ha from CD, 30 kg/ha from Urea + 150kg/ha from CD) and single level of P & K.(25kg P/ha from TSP + 60kg K/ha from MP)

Integrated effect of organic and inorganic fertilizers at different levels created a significant impact on growth, yield and nutrient content of tomato plants and fruits. The tallest plants of 67.03 cm was produced with 80 kg N/ha (T_5 treatment) and shortest plant of 47.50 cm was found in control treatment. It was observed that plant height increased gradually with the increasing of nitrogen doses up to 80 kg N/ha. This might be due to higher availability of N and their uptake that progressively enhanced the vegetative growth of the plant. The highest numbers of leaf 98.89 was recorded from the T_4 treatment and lowest number of leaf 61.59 was found in control treatment. It was observed that the application of N up to 105 Kg/ha increased number of leafs per plant.

The highest number of fruit per plant (67.50) was obtained with the application of 80 kg N/ha. The lowest no. of fruit per plant (38.51) was produced by control treatment. It was observed that the application of N up to 80 Kg/ha increased number of fruits per plant. The highest yield per plot (46.43 kg) was obtained in T_5 treatment and the lowest yield per plot (26.66 kg) was recorded in control treatment. Yield per plot increased with increasing levels of N up to 80 Kg/ha. Further addition of N above 80 kg/ha decreased yield per plot of tomato. Plant receiving N at the rate of 105 kg/ha (T_4) produced significantly higher yield per hectare (77.39 t), which was statistically similar with 80 kg N/ha. The lowest yield per hectare (44.43 t/ha) was recorded in control treatment.

The highest N content in plant was 1.63%, which was observed in T_4 treatment. The lowest N content in plant was 0.82%, which was found in control treatment. The result revealed that the N content in plant was increased with increasing rate of nitrogen up to 105 kg/ha, with further addition of nitrogen it was decreased. The combined effect of organic and inorganic fertilizer on N content in plant was significant. The highest concentration of N obtained in T_4 treatment and the minimum plant-N was found in control treatment. Maximum P content of 0.386% was found in T_1 treatment and the minimum P content of 0.124 % was found in control treatment. The highest N content in soil was 0.081%, which was observed in T_1 treatment and it was statistically similar with T_2, T_3, T_4 and T_5 treatments. The lowest N content in soil was 0.05%, which was found in control treatment. The result revealed that the N content in post harvest soil was increased with increasing rate of nitrogen up to 180 kg/ha. The highest P content in soil was 25.67 ppm, which was observed in T_4 treatment. The lowest P content in soil was 20.60 ppm, which was found in control treatment. The highest S content in post harvest soil was 14.45 ppm, which was observed inT_5 treatment and it was statistically similar with T_6, T_7 and T_8 treatments. The lowest S content in soil was 11.28 ppm, which was found in T_2 treatment.

From the present study, the following conclusion may be drawn –

- Integrated effect of organic and inorganic fertilizer on the yield and performance of tomato was found to be positive and significant.
- Such study is needed to be repeated in different agro-ecological zones (AEZ) of Bangladesh for the evaluation of regional adaptability.

Chapter 6
References

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Chapter 7
Appendices

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Appendices

Appendix I. **Monthly record of air temperature, rainfall, relative humidity, soil temperature and sunshine of the experimental site during the period from November 11 to March 12**

Month	*Air temperature (^0C)		*Relative Humidity (%)	*Rainfall (mm) (total)	*Sunshine (hr)
	Maximum	Minimum			
November 11	21.4	13.4	65	00	6.2
December 11	20.6	12.5	66	00	6.5
January 12	24.5	12.4	68	00	5.7
February 12	27.1	16.7	67	30	6.7
March 12	31.4	19.6	54	11	8.2

Appendix II. **Analysis of variance of the data on plant height and no. of leaf / plant of tomato as influenced by integrated nutrient management**

Source	Degree of freedom	Mean Square	
		Plant height/plot (cm)	No. of leaf/plant/plot
Replication	2	2.936	1.163
Factor A	8	177.248**	474.717**
Error	16	0.806	0.851

Appendix III. **Analysis of variance of the data on number of fruit/plant, yield per plot (kg) and yield per hectare (t) of tomato as influenced by integrated nutrient management**

Sourec	Degree of freedom	Mean Square		
		No. of fruit/plant	Yield per plot (kg)	Yield per hectare (t)
Replication	2	1.204	0.835	1.037
Factor A	8	282.985**	10.189**	7.286**
Error	16	0.505	0.272	0.411

Appendix IV. **Analysis of variance of the data on nitrogen and phosphorus content in tomato plant as influenced by integrated nutrient management**

Source	Degree of freedom	Mean Square	
		Content in shoot (ppm)	
		N	P
Replication	2	0.002	1.43
Factor A	8	9.97**	3.602**
Error	16	1.1	1.12

Appendix V. **Analysis of variance of the data on nitrogen, phosphorus and sulphur available in post harvest soil of tomato as influenced by integrated nutrient management**

Source	Degree of freedom	Mean Square		
		Nutrient present in post harvest soil		
		Total N (%)	Available P (ppm)	Available S (ppm)
Replication	2	0.027	0.004	0.002
Factor A	8	0.286**	0.072**	0.0002**
Error	16	0.008	0.002	0.0001